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(54) IMPROVEMENTS IN OR RELATING TO MARINE STRUCTURES

(71) We, RICHARD PAVRY and PETER JOHN PAVRY, both British subjects of 90 Edge Hill, Wimbledon, London SW19 4NW, (formerly of 35 Burghley Road, Wimbledon, London SW19 5HL), do hereby declare this invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to supports and anchorages for marine structures and is concerned with the problem of securing to the sea bed the bases of marine gravity structures or the anchorages of buoyant marine structures. Hereinafter the term "base" will be used to include not only the part of a gravity structure which rests on the sea bed, but also the anchorage secured to the sea bed to hold in position the anchor ropes of a buoyant structure.

It is an object of the invention to provide a simple method of anchoring the base of a marine structure to the sea bed.

From one aspect, the invention consists in a method of anchoring the base of a marine structure to the sea bed, wherein longitudinally extending piles each provided with an externally screw threaded portion at one end and an enlarged head at the other end are inserted through apertures in the base of the structure and rotated about their longitudinal axes to cause the screw threaded portions to penetrate and enter the sea bed far enough for the enlarged heads to engage the upper surface of the base, and wherein rotation of each pile to cause it to enter the sea bed is produced by means of a remotely-controlled capstan.

From another aspect, the invention consists in a marine structure having a base secured in position on the sea bed by a method in accordance with the preceding paragraph.

The piles may be in the form of solid shafts or in the form of tubular members. Preferably, the screw threaded portion on each pile is constituted by one or more helical blades secured to the outer surface of the pile.

When the pile is tubular, the lower end, which is the end provided with the screw threaded portion, may be open-ended or it may be provided with a conical closure member. The piles are preferably constructed of steel, but they may consist of concrete, or of steel and concrete.

Rotation of each pile to cause it to enter the sea bed is preferably produced by means of a remotely controlled electrical or hydraulic capstan having a sealed motor. In use, such a capstan is lowered by means of a crane on to the head of the pile which is positioned in an aperture in the base with its lower screw threaded end resting on the sea bed. The head of each pile is provided with a notch or a toothed device to receive a driving member on the capstan. While being lowered, and while in position, the capstan is preferably guided by vertical wire ropes which pass through rope guide attachments on either side of the capstan. To prevent the capstan from rotating when it is driving the pile, the capstan is preferably provided with a forked arm capable of cooperating with a vertical post set in the base or in the sea bed.

If the piles are tubular and open-ended, jetting and soil lifting attachments may be fitted to, or associated with, the capstan to pump water or air down the interior of the pile. Alternatively, or in addition, suction means may be provided to draw the soil up the interior of the pile as the lower end penetrates the sea bed.

Methods of performing the invention will now be described with reference to the accompanying diagrammatic drawings, in which:—

Figure 1 is a side view of one form of

pile for use in anchoring the base of a marine structure in accordance with the invention;

Figure 2 is a cross-sectional view of the pile shown in Figure 1 taken on the line A-A looking in the direction of the arrows;

Figure 3 is a side view of a part of an alternative form of pile for use in accordance with the invention;

Figure 4 is a plan view of part of the apparatus used for driving a pile as illustrated in any of Figures 1 to 3 into the sea bed;

Figure 5 is a side view of the part of the apparatus shown in Figure 4 also showing a pile in position;

Figure 6 is a cross-sectional view of the pile shown in Figure 5 taken on the line B-B looking in the direction of the arrows;

Figure 7 is a plan view of a base for a marine structure in accordance with the invention; and

Figure 8 is an elevation of the base illustrated in Figure 7.

The pile illustrated in Figures 1 and 2 is in the form of a cylindrical steel shaft 1 which is provided with a toothed and flanged head 2. The lower end 3 of the shaft, remote from the head 2, is open and two screw blades 4 and 5 are welded to the outside of the shaft 1 a short distance above the open end 3.

Figure 3 shows a modified form of pile in which the open end 3 of the shaft 1 is provided with a conical closure member 6. The conical member 6 is provided with a number of apertures 7 designed to enable water to be jetted out while the pile is being driven into the sea bed.

Figures 7 and 8 show one type of base for a buoyant platform. This base is hexagonal and consists of a concrete structure 8 provided with webs 9 and six apertures 10 for receiving piles such as those shown at 11, 12 and 13. The concrete structure is also provided with socket members 14 for receiving and guiding the piles.

To enable the base to be anchored to the sea bed, it will be lowered on to the sea bed with the piles in position in the apertures 10 and the socket members 14 as shown in Figure 8 in the case of the pile 11. The base may be lowered from the buoyant platform which is to be anchored in position, or from any other buoyant platform or vessel by means of wire ropes 19. The ropes 19 may also be used once the base has been fixed in position as the anchor ropes for the buoyant platform. The piles would then be driven into the sea bed to assume the position shown in the case of the piles 13 in Figure 8 by means of a remotely-controlled capstan carried in a cradle 15 and provided with a forked arm 16 adapted to engage a post 17 upstanding from the centre of the base 8. To retain the forked arm in position on the post 17, it is provided with a removable rope strop 18. The forked arm is guided on to the post 17, while the capstan is being lowered, by means of a vertical rope 31 attached to the top of the post.

The cradle 15 is supported from the platform by means of a rope 20 and electric cables and hose couplings such as those shown at 21 lead from the platform to the cradle. If the capstan is driven by an hydraulic motor instead of an electric motor, the electric cable would be replaced by suitable hydraulic pressure lines. The cradle 15 is guided by means of two of the ropes 22 which support the base. As can be seen particularly clearly from Figure 4, each of these ropes passes between a pair of pulleys or guides 25. In Figure 8, the pile 12 is shown being driven into the sea bed by means of the capstan, and it is to be understood that, in the arrangement shown, the capstan has already been used to drive in the piles 13 and will be moved round to drive in the pile 11 after the pile 12 has been inserted to the required depth.

As shown in Figures 5 and 6, four pipes 26 pass down the length of the shaft 1 to carry water under pressure from the pump carried on the platform to jets 27. In addition, or alternatively, compressed air may be rejected from the ends of further pipes 28 which lead down the shaft 1 and are connected to an air compressor also located on the platform. It is to be understood that, in an alternative arrangement, the jet pump, or pumps, may be located on the forked arm 16 instead of on the platform, provided with motor, or motors, driving them can be constructed for underwater operation. Also extending down the shaft 1 is a soil discharge pipe 29. The lower end of this pipe opens above a perforated annular air receiver 30 which is itself located above the jet orifices.

The capstan (which is not shown) is located in the cradle 15 and is provided with a driving member adapted to engage the teeth of the head 2 of the pile.

After the piles have been screwed down to the required level, the heads of the piles are fixed in their respective sockets 14. In the case of the cylindrical piles shown, the interior of each pile would preferably be filled with concrete and the heads of the piles would be concreted into the sockets. This concreting could be carried out by means of a bottom-opening skip lowered by a crane from the buoyant platform and attachments on the skip would enable it to be guided by the vertical wire rope in the same way as the capstan.

WHAT WE CLAIM IS:—

1. A method of anchoring the base of a

marine structure to the sea bed, wherein longitudinally extending piles each provided with an externally screw threaded portion at one end and an enlarged head at the other end are inserted through apertures in the base of the structure and rotated about their longitudinal axes to cause the screw threaded portions to penetrae and enter the sea bed far enough for the enlarged heads to engage the upper surface of the base, and wherein rotation of each pile to cause it to enter the sea bed is produced by means of a remotely-controlled capstan.

2. A method as claimed in Claim 1, each of said externally screw threaded portions comprises a pair of screw blades welded to the outside of the respective pile.

3. A method as claimed in Claim 1 or Claim 2, wherein said capstan is driven by a sealed electrical motor.

4. A method as claimed in Claim 1 or Claim 2, wherein said capstan is driven by a sealed hydraulic motor.

5. A method as claimed in any of the preceding Claims wherein said capstan is lowered by means of a crane on to the head of each of the piles in turn.

6. A method as claimed in Claim 5, wherein the base is lowered to the sea bed with the piles in position in respective apertures in the base so that, when the base is in position on the sea bed, the lower screw threaded end of each pile initially rests on the sea bed.

7. A method as claimed in Claim 6, wherein, to prevent the capstan from rotating when it is driving a pile, the capstan is provided with a forked-arm cooperating with a vertical post set in the base or in the sea bed.

8. A method as claimed in Claim 7, wherein, while the capstan is being lowered, it is guided by vertical wire ropes which pass through rope guide attachments on either side of the capstan and said forked-arm is guided by a further vertical wire rope attached to the top of said post.

9. A method as claimed in any of the preceding Claims, wherein water is jetted out from the base of each pile while the pile is being rotated.

10. A method as claimed in any of the preceding Claims, wherein the marine structure is a buoyant platform, and wherein the base is lowered on to the sea bed from said buoyant platform.

11. A method as claimed in Claim 10 and Claim 2, wherein means for lowering the base and the capstan is located on said platform.

12. A method as claimed in Claim 11, wherein electrical generators, pumps and compressors for handling and controlling the capstan and for pumping air or water down each pile are located on said platform.

13. A method as claimed in Claim 7 or Claim 8, wherein a jet pump for pumping water down each shaft is located on said forked-arm.

14. A method as claimed in Claim 10, wherein the base is lowered on to the sea bed by means of wire ropes which are used to anchor the buoyant platform when the base has been secured to the sea bed.

15. A method as claimed in any of the preceding Claims, wherein each of the apertures in the base is provided with a housing, and wherein, when the piles have been screwed down to the required level, the heads of the piles are fixed in their respective housings.

16. A method as claimed in Claim 15, wherein the heads of the piles are fixed in their respective housings by means of concrete.

17. A method as claimed in Claim 16, wherein the piles are hollow and are filled with concrete before the heads are concreted into the respective housings.

18. A method as claimed in Claim 16 or Claim 17, wherein the concreting is carried out by means of a bottom opening skip lowered by a crane.

19. A marine structure having a base secured in position on the sea bed by a method as claimed in any of the preceding Claims.

20. A marine structure as claimed in Claim 19, wherein the piles are in the form of solid shafts.

21. A marine structure as claimed in Claim 19, wherein the piles are in the form of tubular members.

22. A marine structure as claimed in any of Claims 19 to 21, wherein the screw threaded portion of each pile is constituted by one or more helical blades secured to the outer surface of the pile.

23. A marine structure as claimed in Claim 21, wherein the lower end of each pile is open-ended.

24. A marine structure as claimed in Claim 21, wherein the lower end of each pile is provided with a conical closure member.

25. A marine structure as claimed in any of Claims 19 to 24, wherein the piles are constructed of steel, or concrete, or of steel and concrete.

26. A marine structure as claimed in any of Claims 19 to 25, wherein the head of each pile is toothed to receive a driving member for producing the rotation of the pile.

27. A marine structure as claimed in Claim 21, wherein means are provided in the interior of each pile to pump water or air down the pile to the lower end thereof.

28. A marine structure as claimed in Claim 21 or Claim 27, including suction means for drawing soil up the interior of the pile.

29. A method of anchoring a base of a marine structure to the sea bed substantially as hereinbefore described with reference to, and as illustrated in, the accompanying diagrammatic drawings.

30. A marine structure having a base secured in position on the sea bed substantially as hereinbefore described with reference to, and as illustrated, in the accompanying diagramamtic drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1.

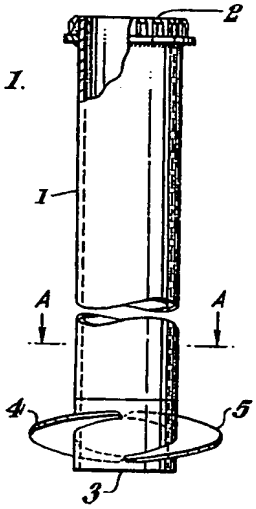


Fig. 2.

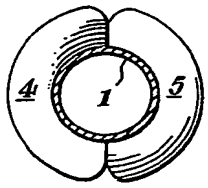


Fig. 3.

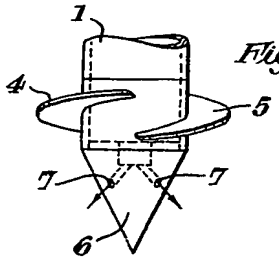


Fig. 4.

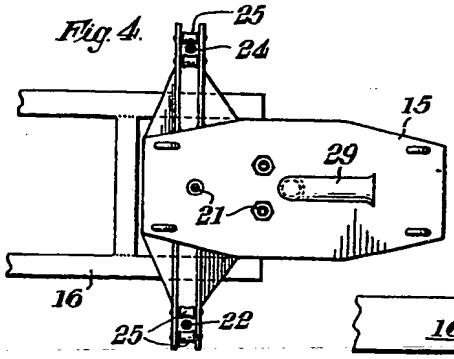


Fig. 5.

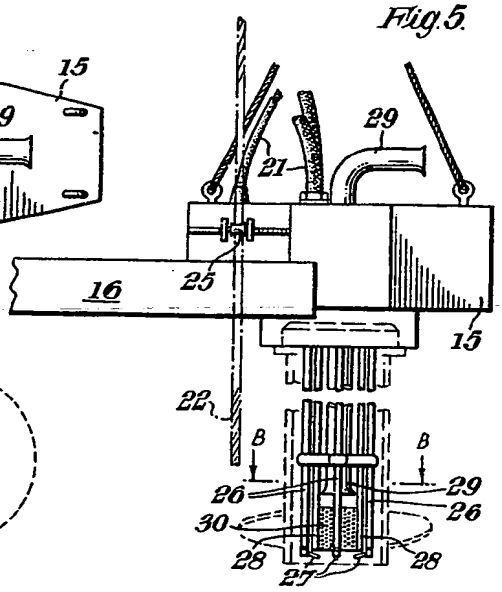
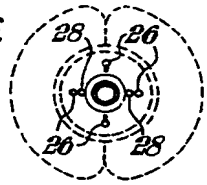


Fig. 6.



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Sheet 2

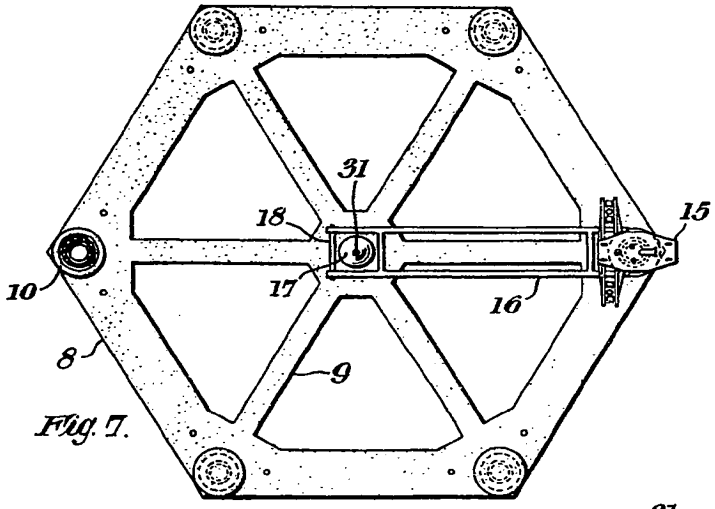

Fig. 7.

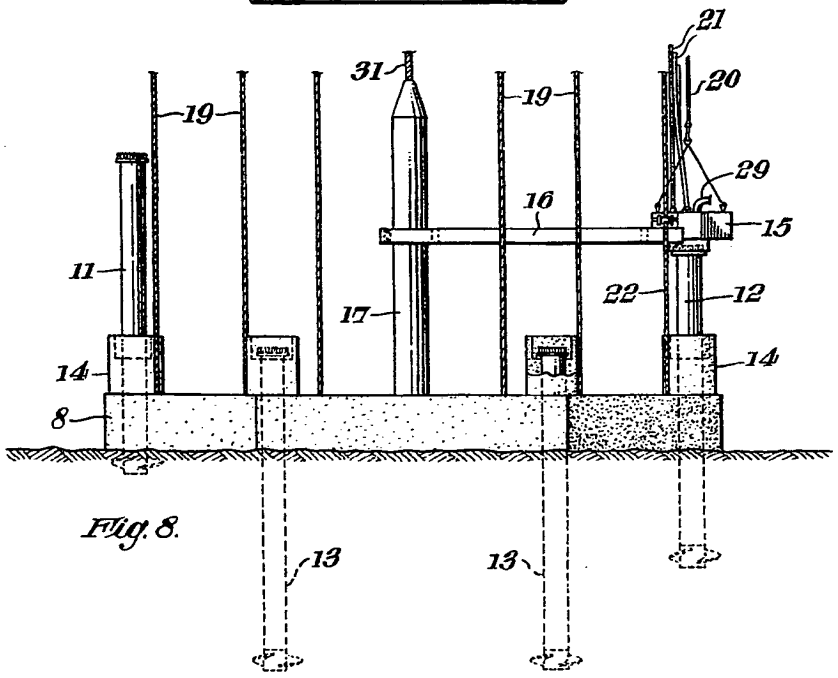

Fig. 8.